EDUCATIONAL MODULE

TITLE:

Shoebox Shade

AUTHOR:

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GRADE LEVEL/SUBJECT:

10^{th}-12^{th} grade / Advanced Mathematics / Trigonometry

CIRRUCULUM STANDARD:
Taken from *Principles and Standards for School Mathematics*

- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometrical relationships
- Use visualization, spatial reasoning, and geometric modeling to solve problems
- Use appropriate techniques, tools, and formulas to determine measurements
- Solve problems that arise in mathematics and in other contexts
- Apply and adapt a variety of appropriate strategies to solve problems
- Communicate mathematical thinking coherently and clearly to peers, teachers, and others
- Recognize and apply mathematics in contexts outside of mathematics

OVERVIEW:

In this lesson, students will explore the benefits of shading windows on a house by calculating the optimal overhang measurement for our location and time of year. Their measurements will be tested with a personal model made during class, and compared to other students' models in the class.

PURPOSE:

Through this lesson students will learn about the effects of roof overhangs on buildings and use their trigonometry skills to problem solve.

OBJECTIVES:

After this lab, students will be able to:

- Calculate the angle of the sun for any location at any time
- Design their own experiment
- Record data
- Identify and determine sources of error
- Understand the concept of shading windows

The following individual work rubric provides a means to evaluate student performance:

Standard	Fair	Good	Excellent
a. completeness	incomplete data, observations, and results	data, observations, and results complete but lacking details	all data, observations, and results are complete with organized details
b. calculations	no work shown for obtained answers	some work shown for obtained answers	all work shown and organized for obtained answers
c. data	data is missing or not complete	data is present, but unorganized	data is complete and recorded in correct areas
d. sources of error	sources of error not addressed	sources of error listed	sources of error listed and explained

VOCABULARY:

solar altitude angle
declination
hour angle
overhang
error
source of error

RESOURCES:

handouts
shoeboxes
cardboard
tape
thermometers
compass
ruler
scissors
calculator

PREPARATORY ACTIVITIES AND PREREQUISITE KNOWLEDGE

Students should already know or be familiar with the following:
- angles
- sin, cos, and tan functions
- using a compass
- reading a thermometer
- measurement

Before the first day of the lesson, ask students to bring in shoeboxes for extra credit. Have students talk in groups about how the earth moves around the sun and how that affects the angles of the sun on the earth. Ask students to find out the latitude of your city for homework.

MAIN ACTIVITIES (2 days in block schedule with 90 minute periods):

Day 1

Introduction (10-15 minutes)

Ask students what the latitude of your city is and how they found out.
Have the students talk about the climate in your city, and about how much sun there is. Students should think about their own homes and how much sun comes through the windows.

Introduce Project and Assignments (20 minutes)

Hand out project packet and review each page with the class
Fill in the "Sun and Earth" section of the packet
Review trigonometry functions
Review with students how to use a compass

Group Work (45 minutes)

Students break into groups of 4
Give each group the Shoebox Shade Worksheet
Answer any questions
Give each group a shoebox, ruler, scissors, and cardboard
Let students create their shoebox house and make calculations for the optimal roof overhang
Students fill in first page of the worksheet

Class Wrap-Up (10 minutes)

Clean up supplies and place boxes in reserved place
Quick review of activities for tomorrow and the group assignment

Answer any questions

Day 2

Introduction (10 minutes)

Review the day's activities
Ask students what needs to be turned in at the end of class

Group Work (50 minutes)

Hand out a compass and two thermometers to each group
Let groups go outside and set up shoeboxes
Students test their overhang and record data
Students experiment with a new overhang and record data
Complete worksheet

Discussion (20 minutes)

Groups share what they learned from the project
Talk about energy and how shading windows helps

Class Wrap-Up (10 minutes)

Collect group packets for grading
Introduce next lesson